Reflectance Spectroscopy of Carbonaceous Meteorites and Insoluble Organic Matter for Interpretation of Spacecraft Data. H. H. Kaplan[1] and R. E. Milliken[1]. [1]Brown University, Dept. of Earth, Environmental, and Planetary Sciences, (email: Hannah_Kaplan@Brown.edu).

Introduction: The recent detection of aliphatic organics on the dwarf planet Ceres has led to renewed discussion about the use of near-infrared reflectance spectroscopy to detect and characterize organic compounds on planetary surfaces [1,2]. Multiple spacecraft carrying reflectance spectrometers will soon visit other bodies in the asteroid belt (e.g. Bennu and Ryugu) increasing the likelihood of additional organic detections. To support interpretation of near-infrared organic detections on primitive bodies, we present laboratory spectra of carbonaceous chondrite (CC) meteorites and insoluble organic matter (IOM) extracted from those meteorites as spectral analogs.

Methods: Reflectance spectra were collected from 0.35 – 25 μm for 27 particulate IOM samples. These IOM have known elemental abundances from previous measurements [e.g. 4] allowing for a comparison between chemistry and spectral properties. In addition to the IOM, 92 meteorite spectra were collected from the RELAB database representing 62 distinct meteorite samples, also with known elemental chemistry for their bulk and organic components.

Dawn VIR hyperspectral images of Ceres' surface, including organic-rich regions, were then compared to these laboratory samples. One spectral image, taken over Ernutet crater, was modeled using methods similar to [1] but with the laboratory measured IOM as a spectral endmember.

Results and Discussion: The IOM measured here were uniformly dark (albedo < 0.03). Spectra became darker and flatter with decreasing H/C (at.) ratio. Absorption strength at 3.4 μm (due to aliphatic CH) also decreased with H/C, until the absorption feature disappeared entirely at H/C < ~0.4. Previous work has demonstrated the link between IOM H/C ratio and thermal alteration on the asteroid parent body [4], so these spectral features may be useful for interpreting thermal history.

Meteorite spectra appeared similarly to be influenced by the H/C of their IOM at 3.4 μm. However, this absorption feature also reflects the abundance (total C, wt.%) of organics incorporated into the bulk meteorite. Spectral models of the 3 μm OH/H_2O and 3.4 μm organic absorptions were able to simultaneously estimate organic and phyllosilicate (e.g. bulk H) abundances from the meteorite spectra, a technique that may be applied to returned spacecraft data.

Ceres has an unusually strong 3.4 μm absorption in comparison to the IOM and meteorite spectra. When the IOM spectra were used to model the organic-rich regions of Ceres, organic abundances of ~45-65% were predicted. Spectral abundance was dependent on the H/C composition of the spectral endmember, so only a range of abundances can be estimated unless organic composition is known. Origin theories for organics on Ceres must consider the presence of a high concentration of IOM-like organics.

Conclusions: A spectral library of IOM and rigorous study of IOM and meteorite spectral properties is important for comparative interpretation and spectral modeling of spacecraft organic detections.

References: [1] De Sanctis, M. C. et al. Science 355, 719–722 (2017). [2] Pieters, C. M., et al. Meteorit. Planet. Sci, (2017). [3] Alexander, C. M. O'D., et al. GCA 71, 4380–4403 (2007)